



100-N Area RI/FS Work Plan

HAB River & Plateau
Committee

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100-NR-1 / NR-2 Operable Unit

- **234 facilities**
- **175 waste sites**
- **4 RCRA designated TSD facilities ***
- **Sr-90 GW plume unique to this operable unit**
- **No persistent chromium plume in groundwater**
- **Petroleum spill**



* RCRA TSD's: 1301-N & 1325-N LWDF's, 1324N Surface Impoundment, 1324-NA Percolation Pond

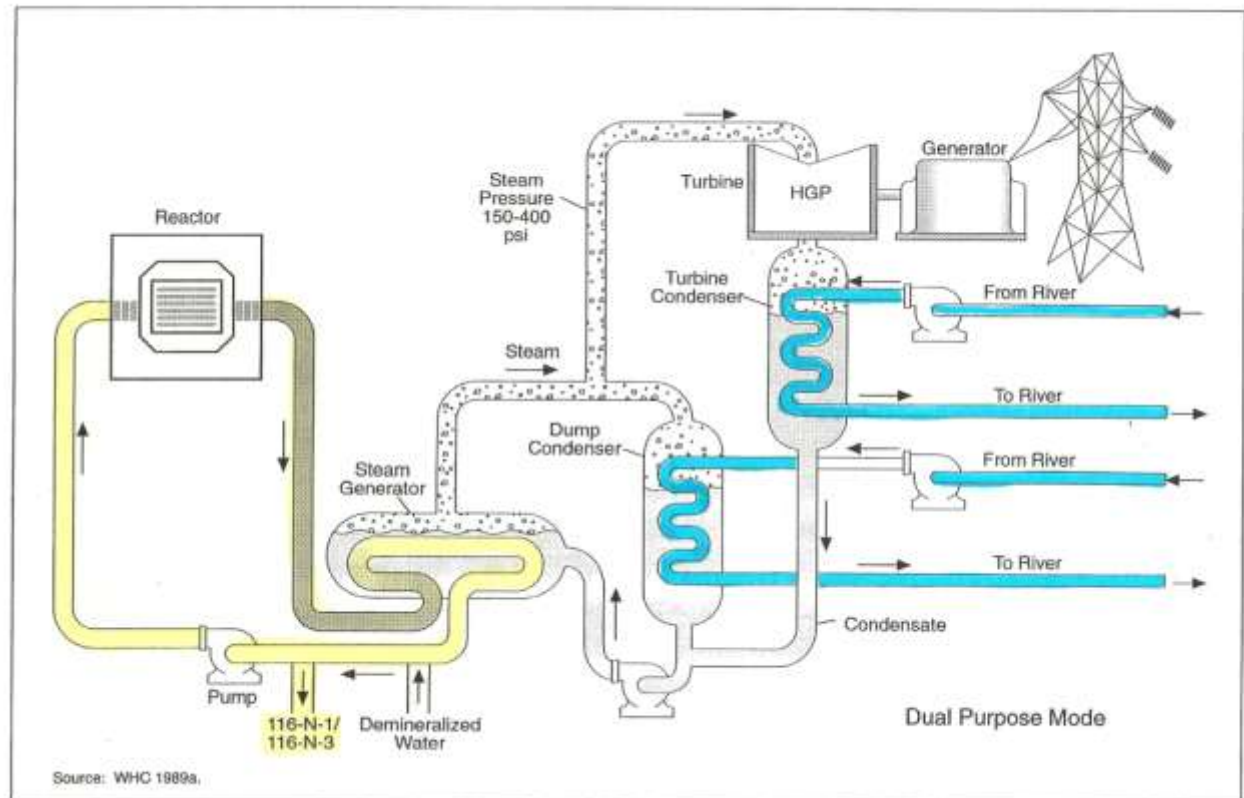
N Reactor Operational History

- Reactor constructed from 1958-1963
- Full Production started January 1964
- Operated continuously until January 1987
- Placed in Cold Standby Feb. 1988
- Shutdown order issued Sept. 1991



100-N Reactor Liquid Waste Practices

- De-ionized water used for reactor coolant
- Non-radioactive secondary cooling water disposed directly to the river
- Primary coolant passed through N reactor the equivalent of 100 times instead of once in the other single-pass reactors
- 1% of primary cooling water replaced on a continuous basis with secondary cooling water
- Primary coolant discharged to soil column (Feed and Bleed)

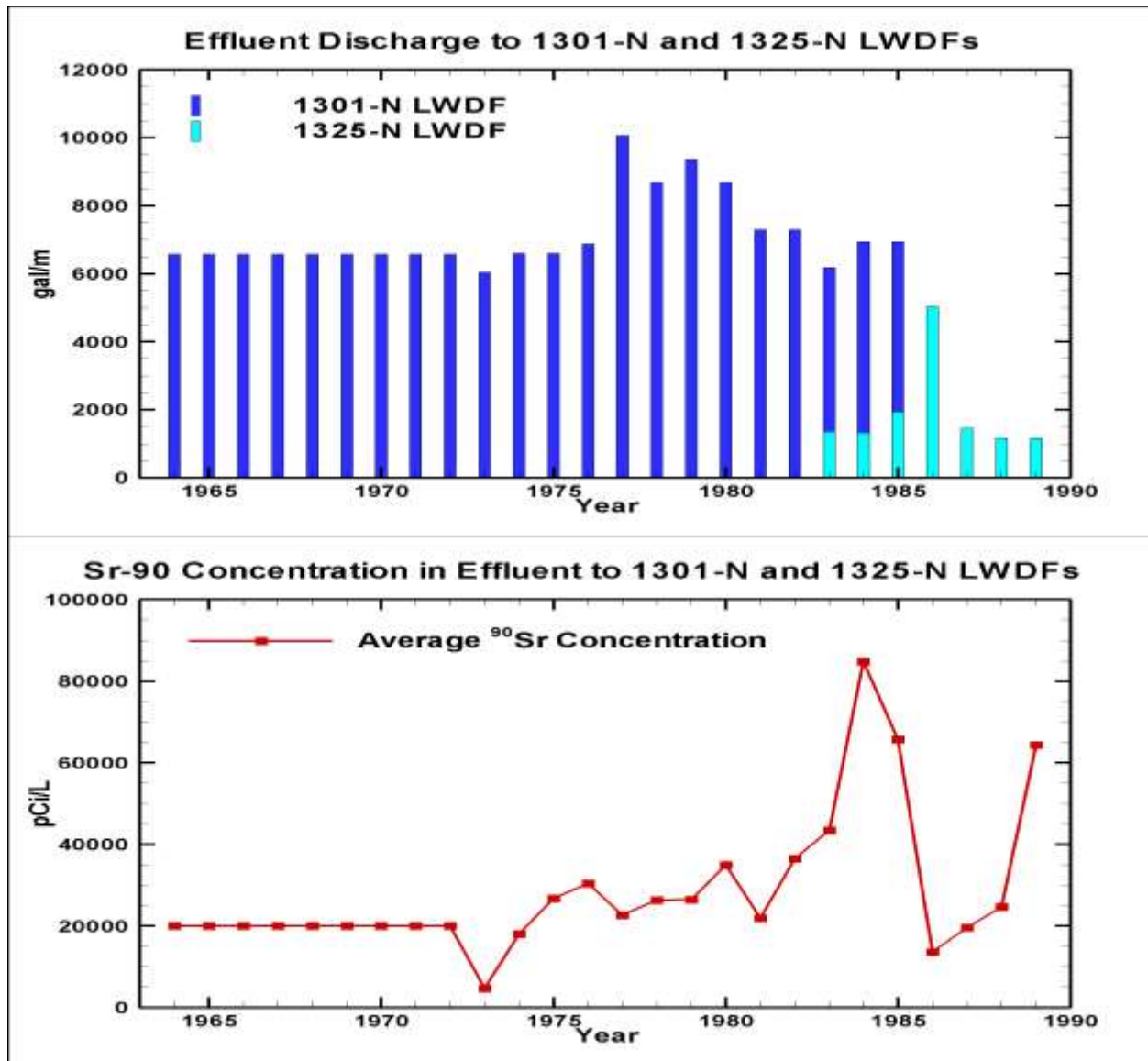


903 1276/27108/2-28-94

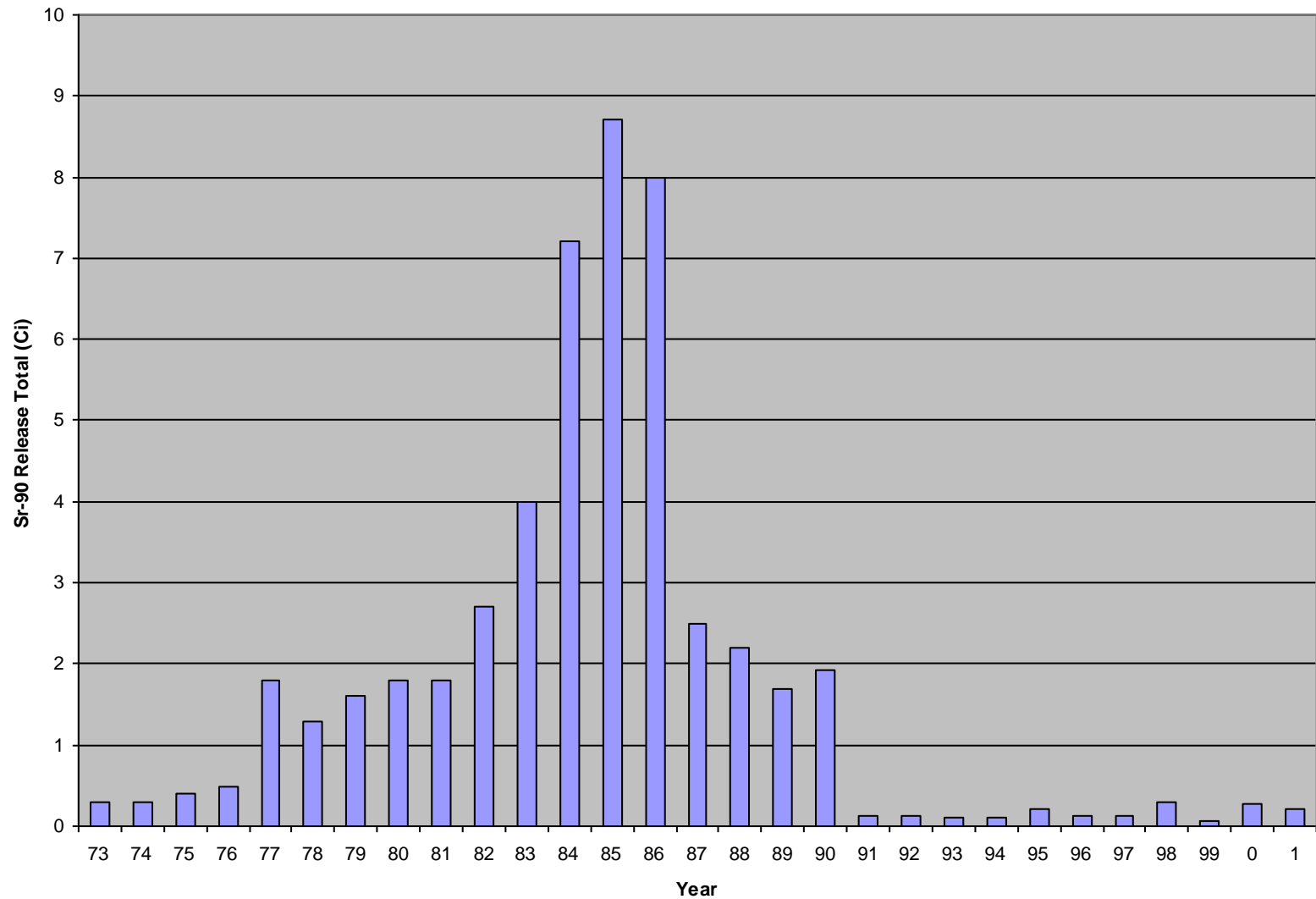


Overflow from Irradiated Fuel Storage Basin was a large contributor of Sr-90 inventory to LWDF's

Effluent Discharge to Cribs



Sr-90 Releases to the Columbia River



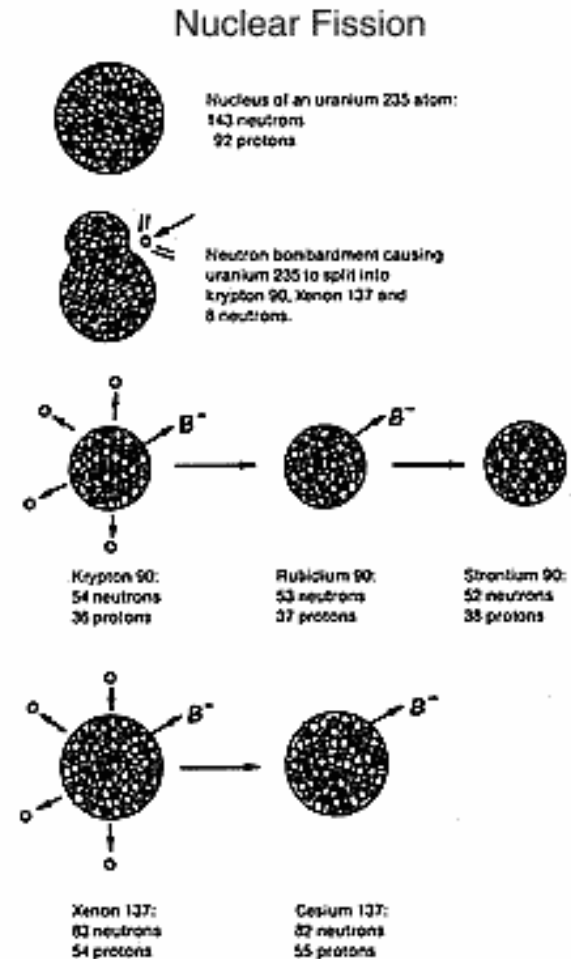
100 N Area Environmental Issues

- Strontium-90 concentrations at N Springs reaches 5,000 pCi/ liter in 1985
- Strontium-90 groundwater plume concentrations peaked in excess of 45,000 pCi/ liter beneath 1325-N in late 1989
- Strontium-90 groundwater plume persists; max concentration $\sim 1,000\times$ MCL

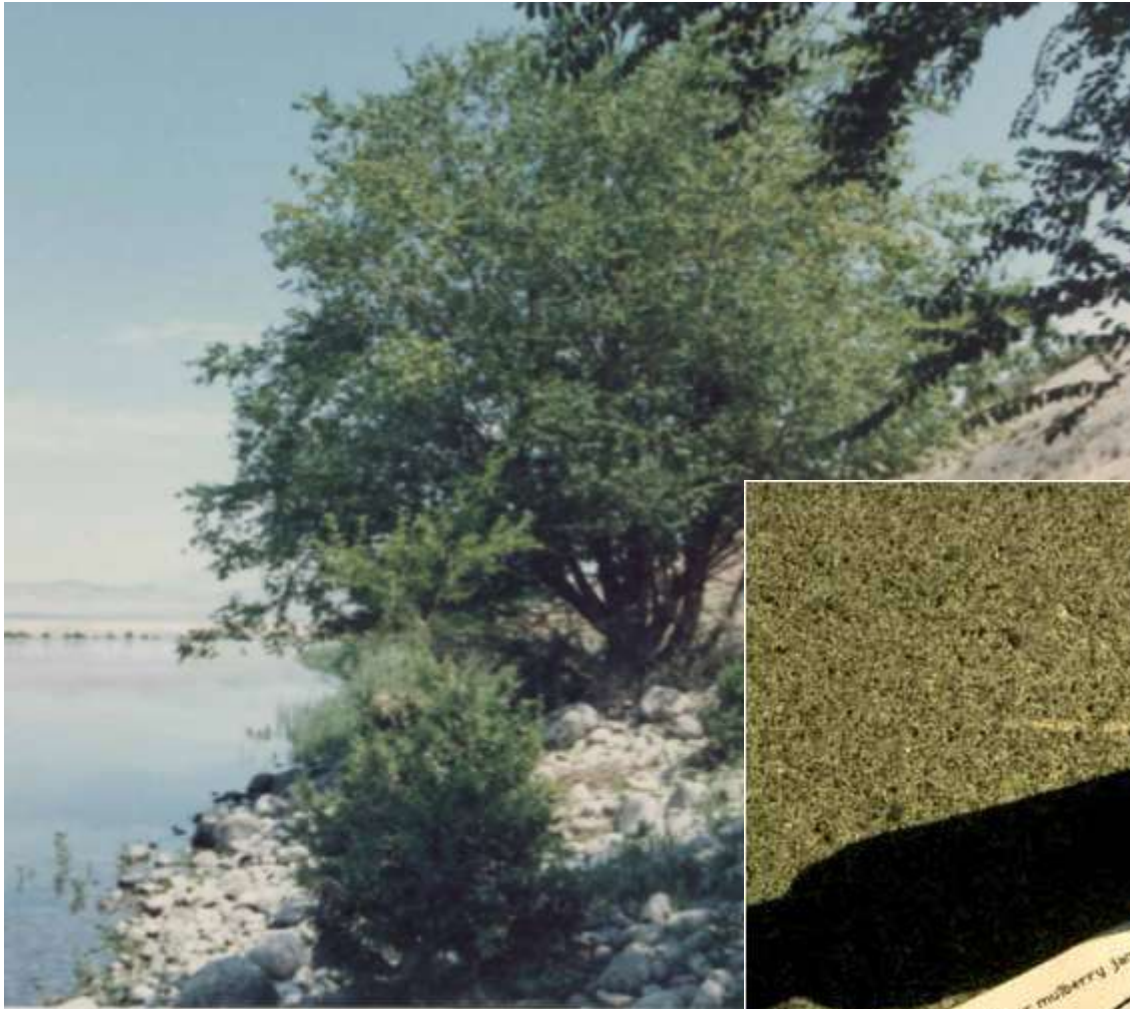


Strontium-90

- Sr-90 is a fission product
- **29.1 year half-life**, beta emitter
 - Decays to Yttrium-90 (64 Hr half-life & higher energy beta emitter) then decays to stable zirconium
 - **50% reduction of Sr-90 activity in less than 30 years**
 - **90% reduction of Sr-90 activity in less than 95 years**
- Behaves biologically similar to calcium
 - ~ 2 Yr biological half-life in infants
 - ~ 5-10 Yr biological half-life in adolescents and adults
- Average world-wide concentration in soil = 0.1 pCi/g
- U.S. average concentration in surface water is 1.9 pCi/L
- U.S. average concentration in groundwater is 0.5 pCi/L



100-N Mulberries 1990



Skyshine at 100-N

- Off-site direct radiation doses (skyshine) exceeded 25 mrem annual dose limit
- Radioactive decay (Co-60) and removal actions have resulted in dose decrease to allowable limits

Tritium at 100-N

- ~6,500 Ci tritium discharged to 1301-N and 1325N cribs
- Max conc. In GW was 400,000 pCi/L in 1972 (Well 199-N-3)
- Tritium concentrations reduced to below DWS except for 1 well (22,000 pCi/L Well 199-N-32)

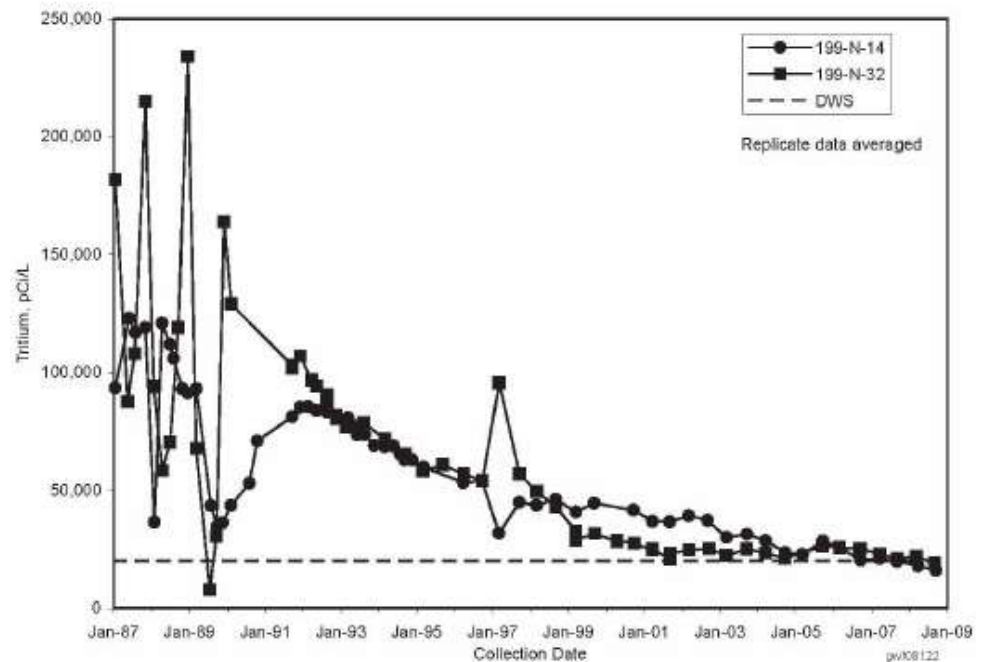


Figure 2-28. Tritium Concentrations in Groundwater near the 116-N-1 and 116-N-3 Waste Sites

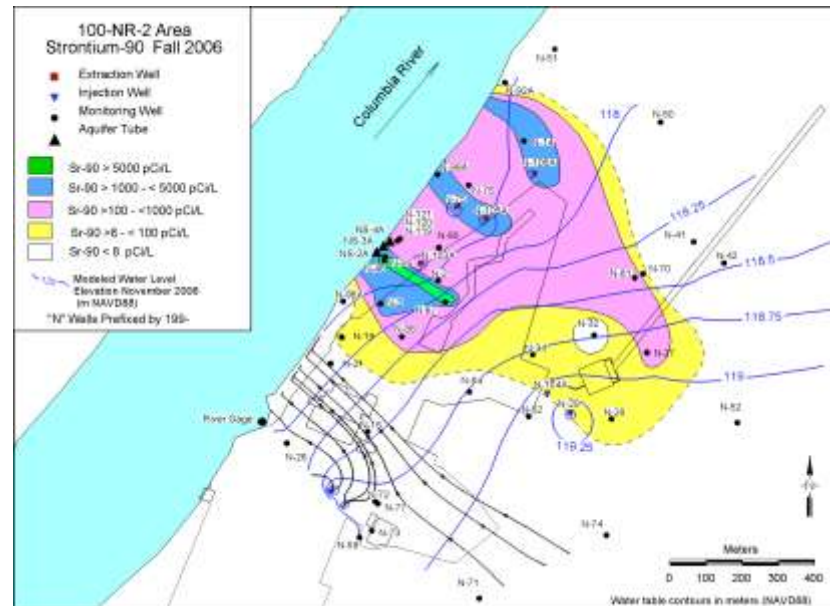
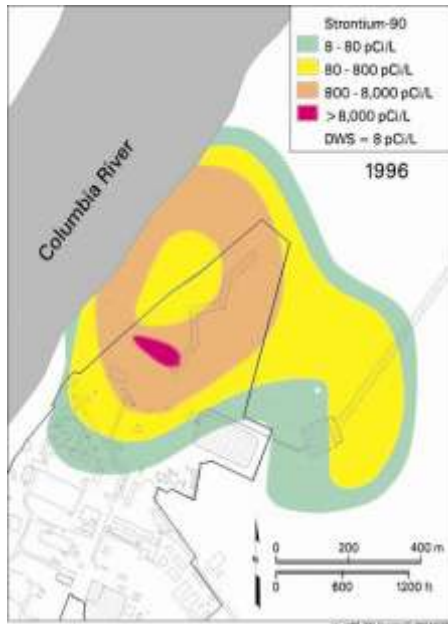
Why is there No Persistent Chromium Plume at 100-N?

- New alloys and materials reduced need for corrosion inhibitors by 100X compared to other 100 Area reactors
- Sodium dichromate only used in primary (recirculation) cooling loop; discontinued in 1972
- Improved product handling
- 54K lbs chromium discharged to 1301-N; flushed by **21 BILLION Gallons** of water; 10 yrs of chromium-free discharge

Strontium-90 Plume Maps

Sr-90 plume over time

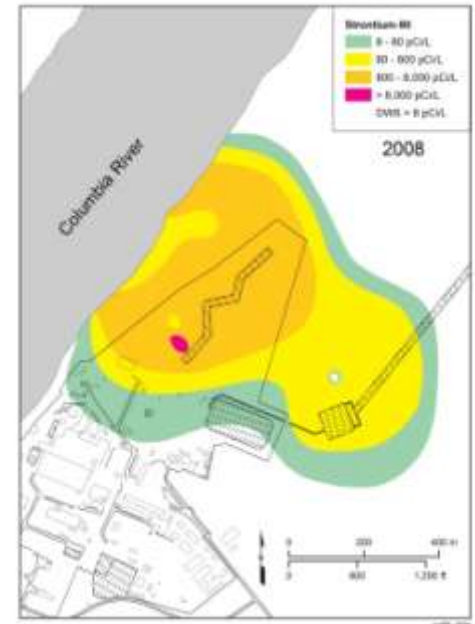
1996



Fall 2006

**Very little change over time,
especially since P&T placed in
cold standby**

2008



1966 Diesel Spill

- ~80,000 gal of diesel spilled in 166-N Tank Farm *
- Interception Trench collected & burned oil through 1967
- ROD for Interim Action requires sorbing free product in wells
- Characterization & remediation efforts underway

* Largest documented petroleum product spill at 100-N



100-N Area RI/FS Work Plan

- Draft Work Plan was transmitted to Ecology December 22, 2009, meeting TPA Milestone M-015-61; 60 day comment period per Section 9.2 of TPA
- The work plan is 5th and last addendum to the Integrated 100 Area RI/FS Work Plan that contains the planning elements common to the 100 Area source and groundwater operable units.
- Initial feedback has been received from Ecology.
- Workshop (open to tribes & stakeholders) scheduled for February 17, 2010 to facilitate work plan review.

100-N TPA Milestones & Target Dates

- **M-015-00D DOE shall complete the RI/FS process through the submittal of a proposed plan for all 100 and 300 area operable units Dec 2012**
 - **M-015-62-T01 Submit a feasibility study report and proposed plan for the 100-NR1 and 100-NR-2 Operable Units including groundwater and soil. The FS report &PP will evaluate the permeable reactive barrier technology and other alternatives and will identify a preferred alternative in accordance with CERCLA requirements Dec 2011**
- **M-015-60 If an amendment to the 100-NR-1/2 record of decision for interim action is issued, DOE shall submit an RD/RA work plan within 6 months after the ROD amendment**
- **M-016-00 Complete remedial actions for all non-tank farm operable units Sept 2024**
 - **M-016-110-T03 DOE shall take actions necessary to contain the Sr-90 plume at the 100-NR-2 Operable Unit such that the default ambient water quality standard (8 pCi/L) for Dr-90 is achieved in the hyporheic zone and river water column Dec 2016**
- **M-016-00A Complete all interim response actions for the 100 Areas Dec 2012**

100-N Area RI/FS Work Plan

The work plan identifies scope of work required to support a remedial decision recommendation via a CERCLA proposed plan due December 2011 (TPA Target Date M-015-16-T01)

- Describes an updated conceptual model based on significant characterization, research & interim remedial action activities since the previous RODs were written.
- Identifies data needs and scope to close them
- SAP for 4 new characterization/monitoring wells
- Continued characterization of 93 source sites scheduled for evaluation/characterization or remediation per ROD for Interim Action
- Preliminary information to determine COPCs, RAO's, remediation goals, and assessment of ARARs
- Describes remediation approach
- Addresses NEPA values
- Includes community relations

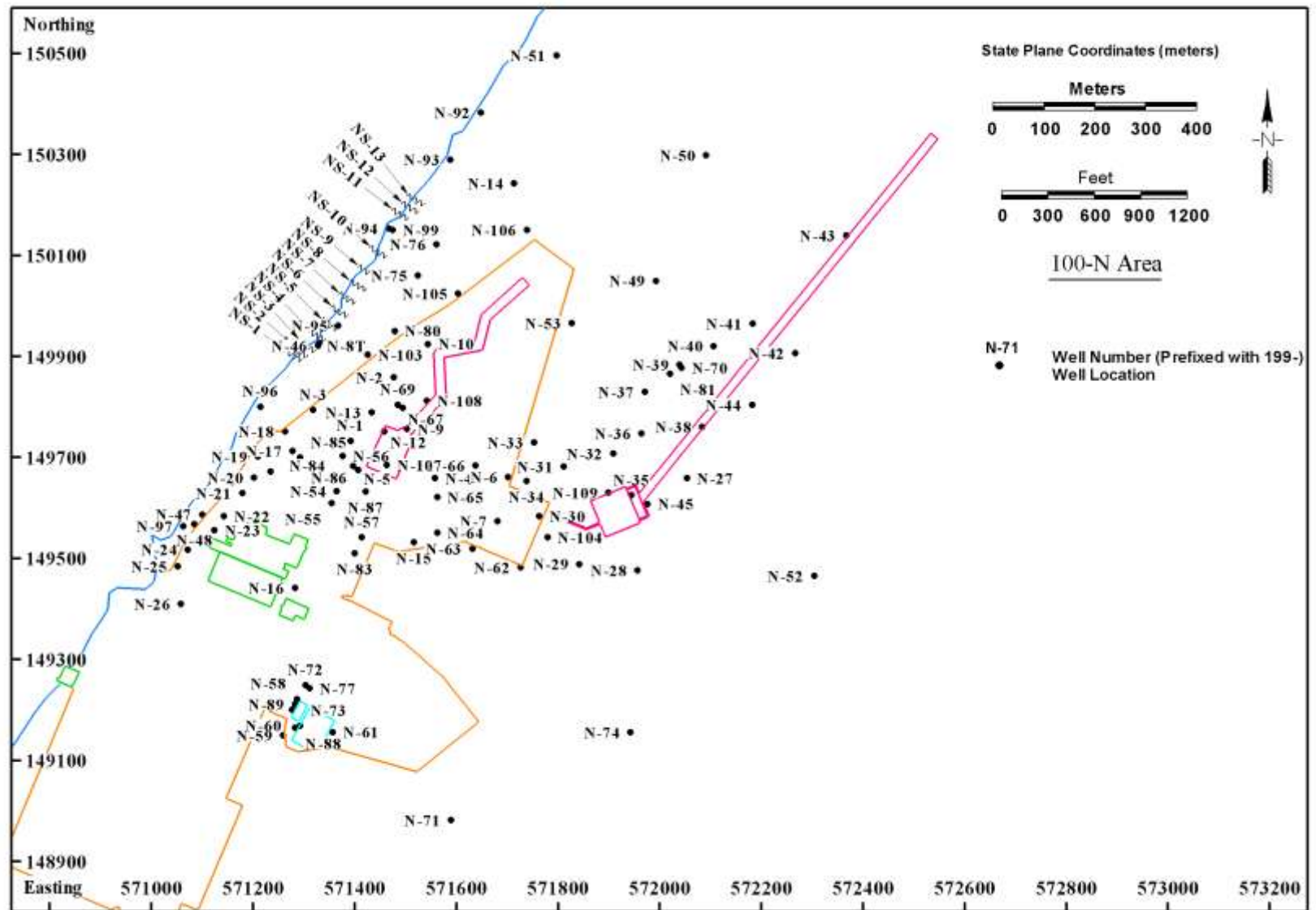
100-N Literature & Data Review

- PNNL-SA-39495 September 2003
- ~220 reports & technical documents reviewed
- Describes:
 - Biological resources
 - Contaminant data & trend plots
 - Review of dose assessments
 - Summarizes modeling efforts and environmental studies

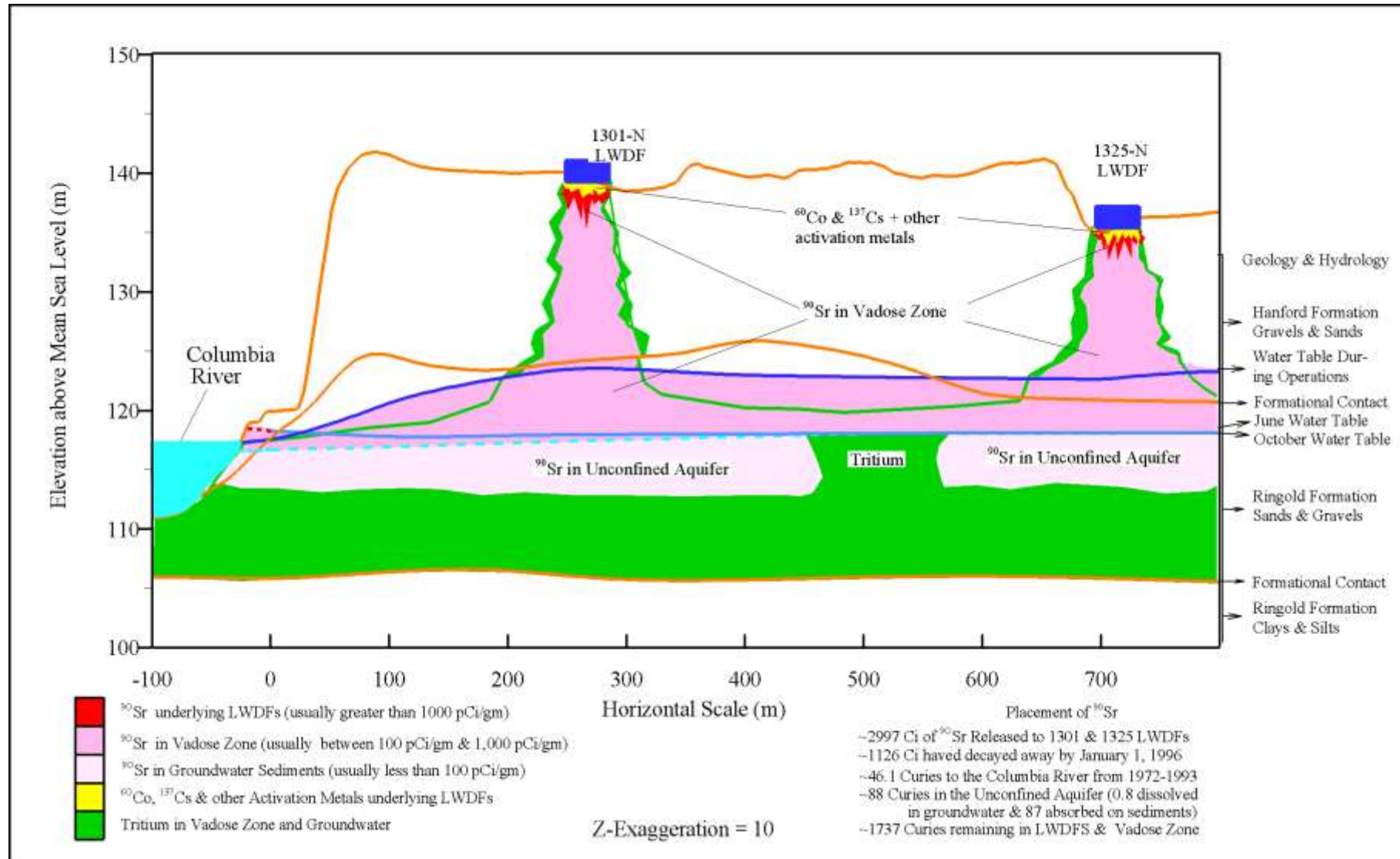
The Work Plan reflects considerable characterization and environmental remediation activities

- Implementation of the bias-for-action concepts described in the Hanford Past Practice Strategy (DOE/RL-91-40, 1991)
- 1999, Interim Remedial Action Record of Decision for the 100-NR-1 and -NR-220 Operable Units of the Hanford 100-N Area, as amended
 - characterizing groundwater plumes and their potential sources,
 - evaluation of ecological impacts,
 - evaluation of potential remedial technologies,
 - implementing remedial actions for groundwater and soil,
 - testing new and alternative treatment methods.

Historic Monitoring 100-N Well Network



Conceptual Model for the 100-N Area



PROGRESS!!! (SLIDE 1)

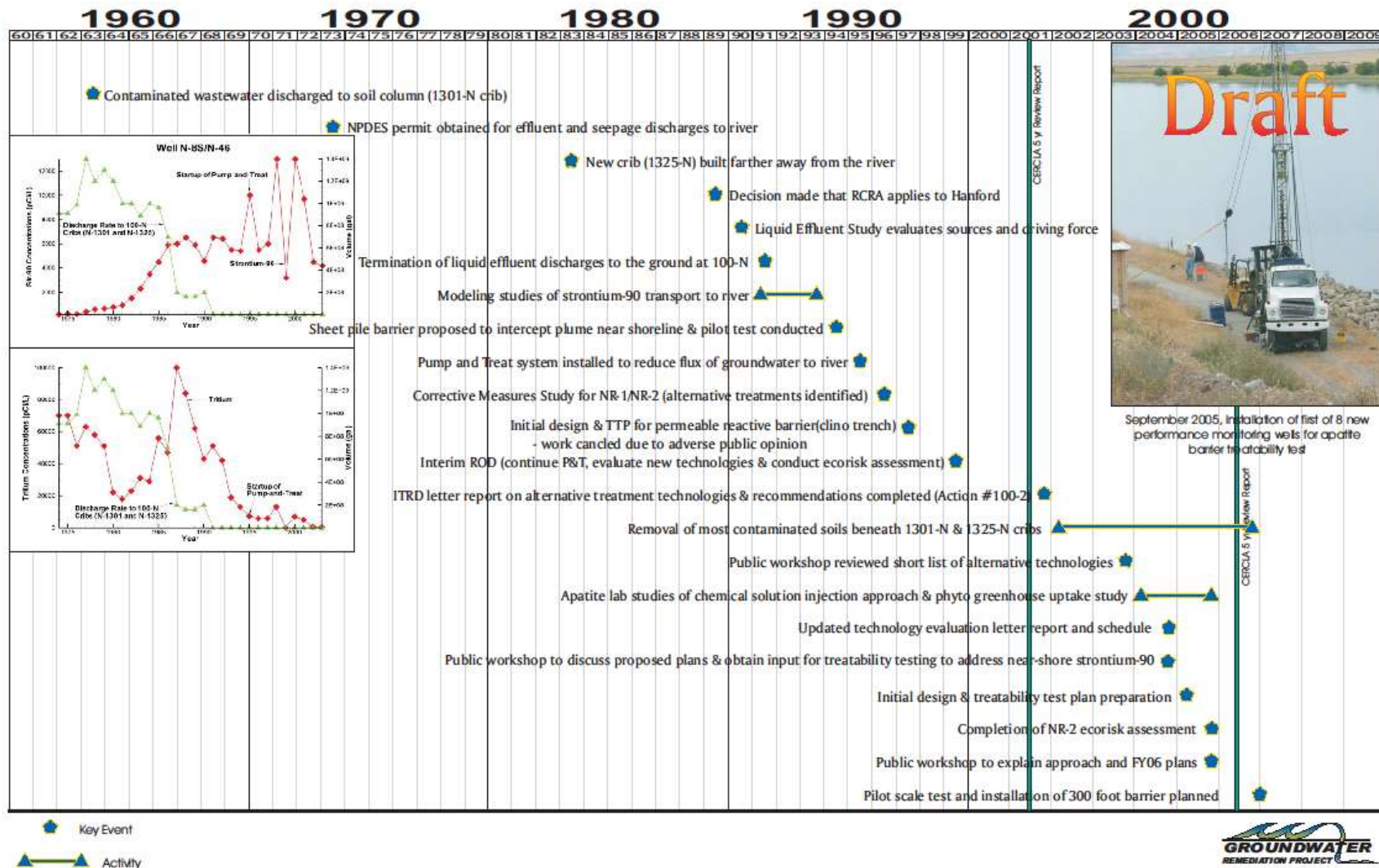
- 76% of the facilities in the decision unit have been demolished or removed.
- Reactor ISS completion is scheduled for September 2011.
- Cleanup of 18 waste sites - including the large liquid waste disposal facilities (source of groundwater contamination)
- Work on an additional 78 waste sites will be initiated in June 2010
- ~108 K tons of contaminated soil and debris have been removed & more than 650 soil samples have been collected to verify cleanup and document cleanup status.
- Orphan site evaluation completed; sampling scheduled for 2010



PROGRESS !!!! (SLIDE 2)

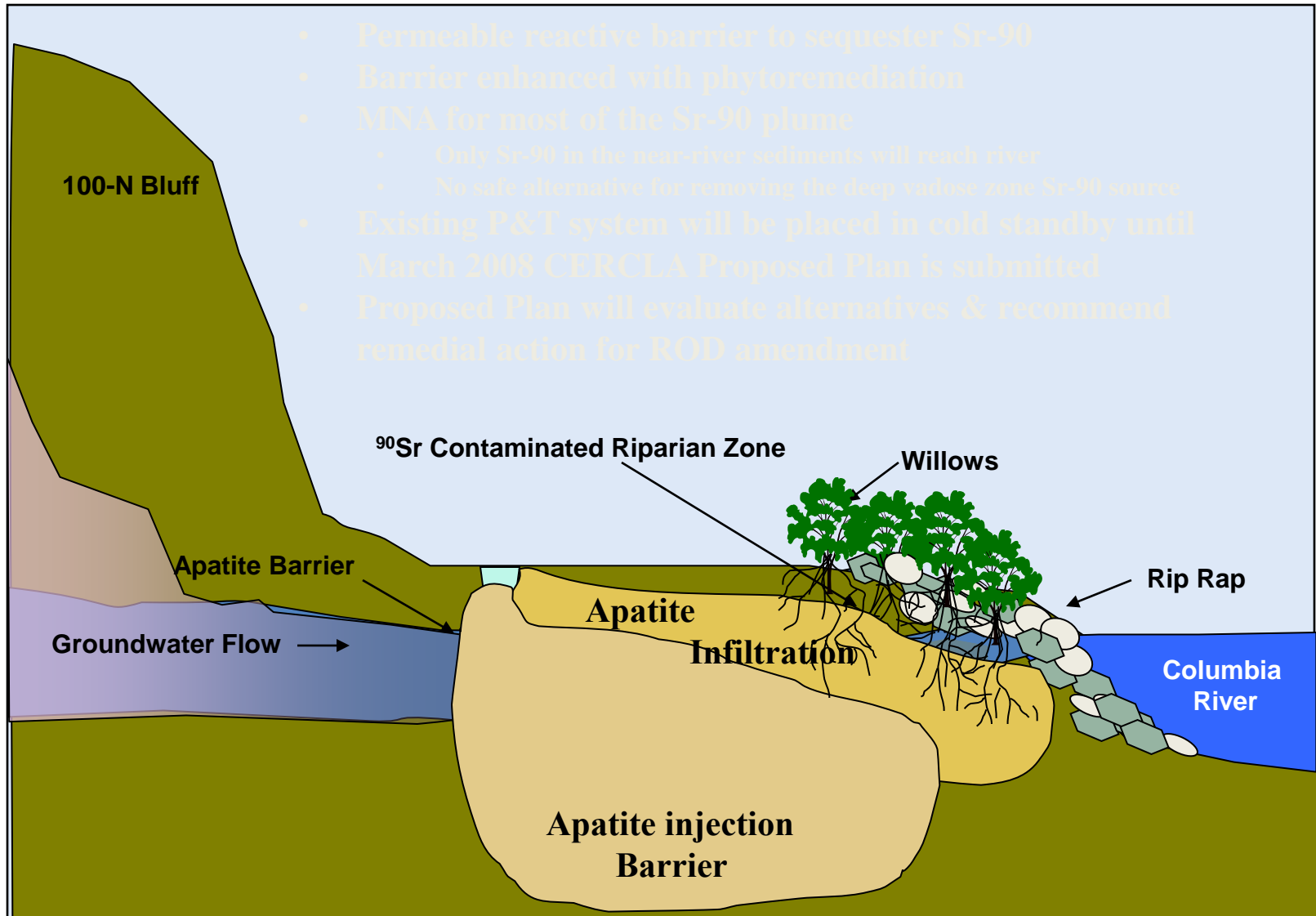
- **Pump-and-treat has been implemented and evaluated; and, a hinged sheet-pile barrier, designed to supplement the pump-and-treat system was tested in 1994**
- **Testing a more promising groundwater remediation technology (permeable reactive barrier); 171 wells (ARRA Funding) will be constructed for 2700 ft apatite barrier**
- **A supplemental groundwater remediation technology (phytoextraction) is also being tested**
- **The Innovative Treatment and Remediation Demonstration Program evaluated 40 remediation technologies in 1998 that will serve as the basis of the 100-N feasibility study**
- **Characterization and remediation of petroleum contamination has been initiated**
- **Characterization of groundwater upwelling into the river and sediments is underway**
- **An initial assessment of the current impacts of contaminated groundwater plumes on aquatic and riparian zones within the 10-NR-2 Operable Unit was conducted in 2005 and completed in 2009**
- **River Corridor Baseline Risk Assessment is ongoing**

History of Effluent Control and Groundwater Remedial Actions at 100-N



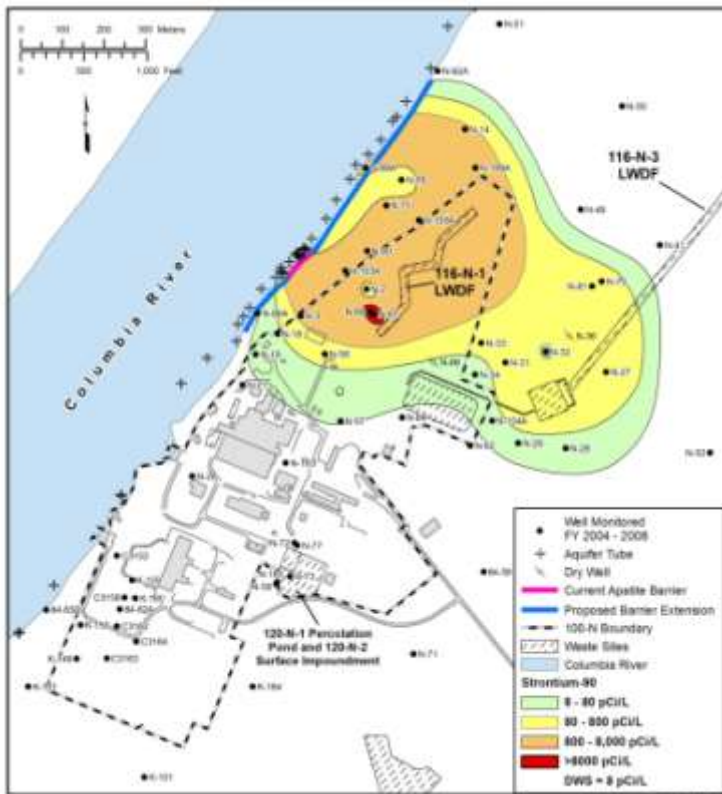
Systems Approach to Address 100-N ^{90}Sr

- Permeable reactive barrier to sequester Sr-90
- Barrier enhanced with phytoremediation
- MNA for most of the Sr-90 plume
 - Only Sr-90 in the near-river sediments will reach river
 - No safe alternative for removing the deep vadose zone Sr-90 source
- Existing P&T system will be placed in cold standby until March 2008 CERCLA Proposed Plan is submitted
- Proposed Plan will evaluate alternatives & recommend remedial action for ROD amendment

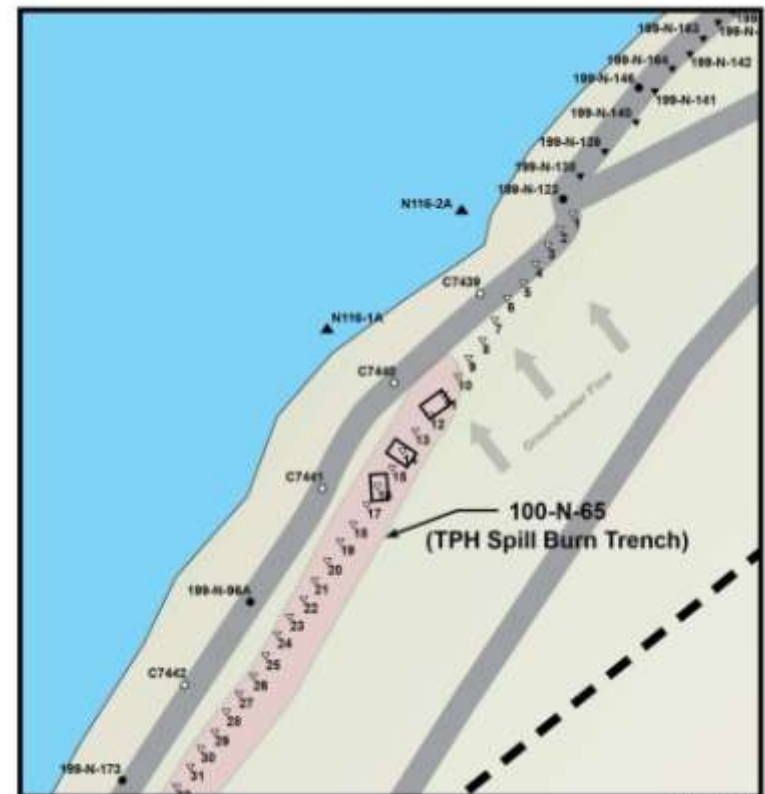


Technology Applications and Demonstrations

Proposed Apatite PRB extensions



Proposed locations for Jet Injection tests



100-N TPA Milestones & Target Dates

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Draft 100-N Proposed Plan to amend the 1999 ROD for Interim Action

- Draft PP submitted December 18, 2009 in accordance with TPA Milestone M-016-14B.
- Rational for IROD Amendment
 - P&T system has provided sufficient information for P&T to be evaluated in the PP
 - Expanded PRB test is needed to meet remediation goals defined in TPA Target M-016-110-T03
 - A “plug-in” approach is proposed for any newly discovered waste site that is similar to the sites included in IROD.
- Ecology has provided initial comments

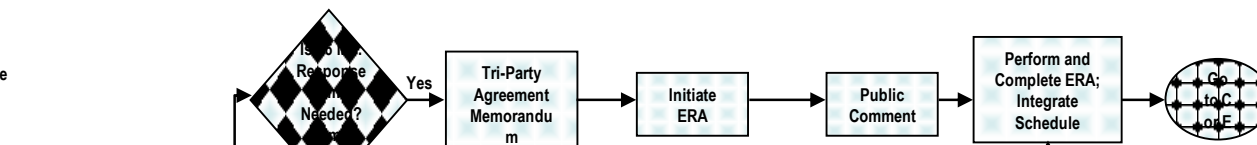
BACKUP SLIDES

100-N Ecological Rept.

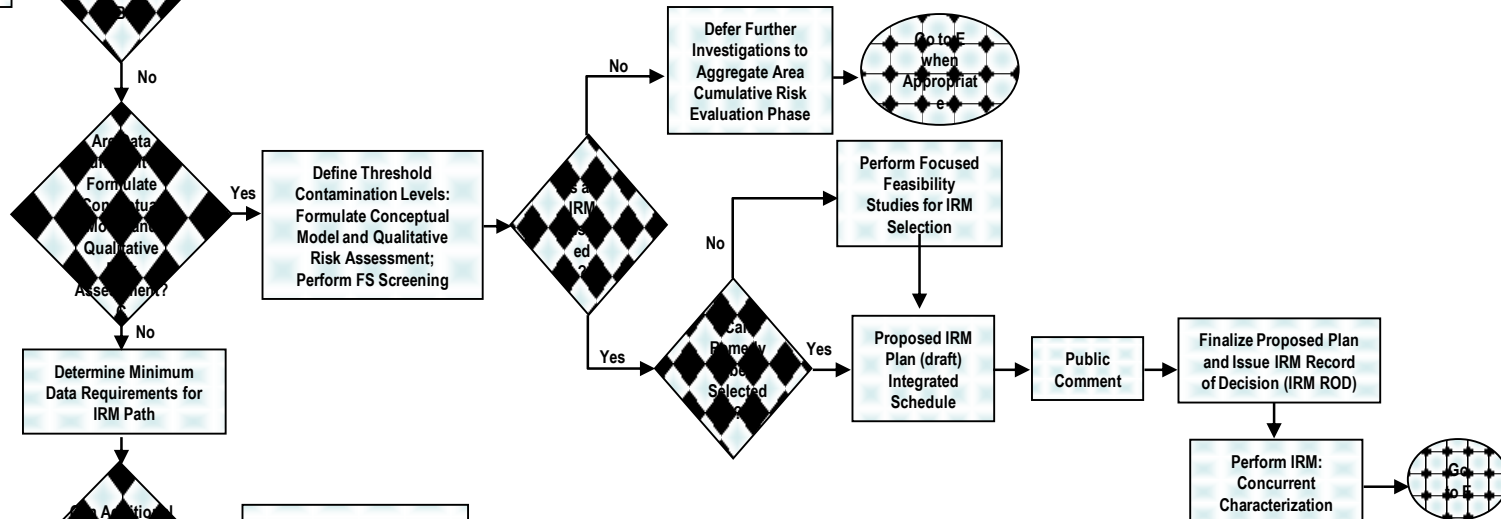
- Delivered to Ecology October 31, 2005; Final document submitted December 2009
- Identified abnormalities the soft tissues of clams
- Diesel fuel spill causing reduced oxygen in a localized shoreline area
- High lead levels in some mice captured at the shoreline

**Expedited Response
Action (ERA) Path**

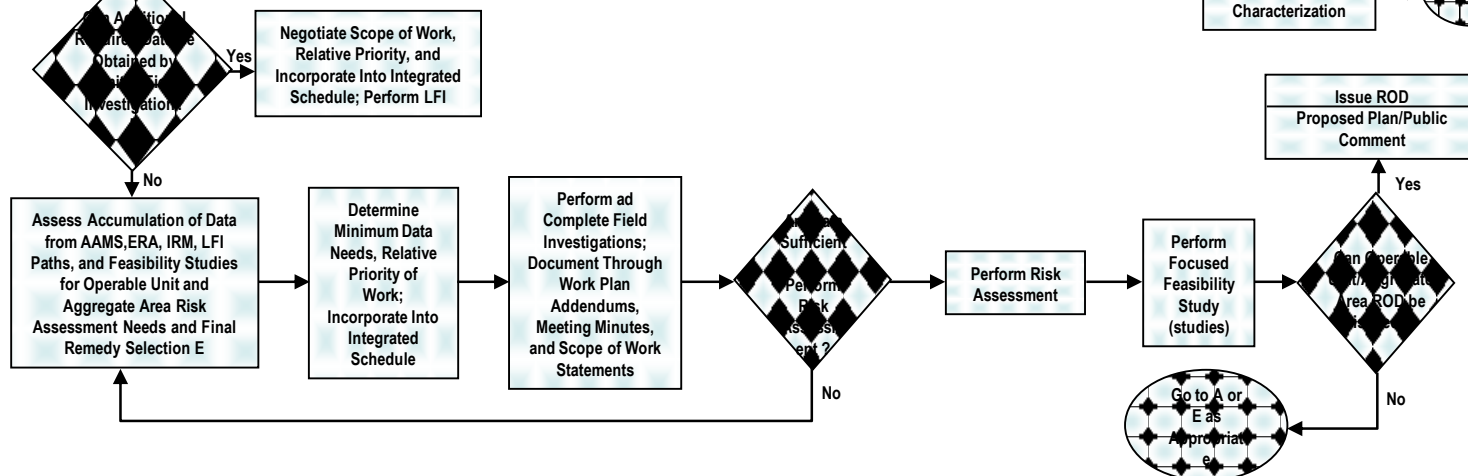
Draft 100 Area
Work Plans
200 Area
AAMSR



**Interim Remedial
Measure (IRM) Path**



**Limited Field Investigation
Path to Achieve Interim
Remedial Measure
(LFI—IRM)**



**Final Remedy
Selection for
Operable Unit**



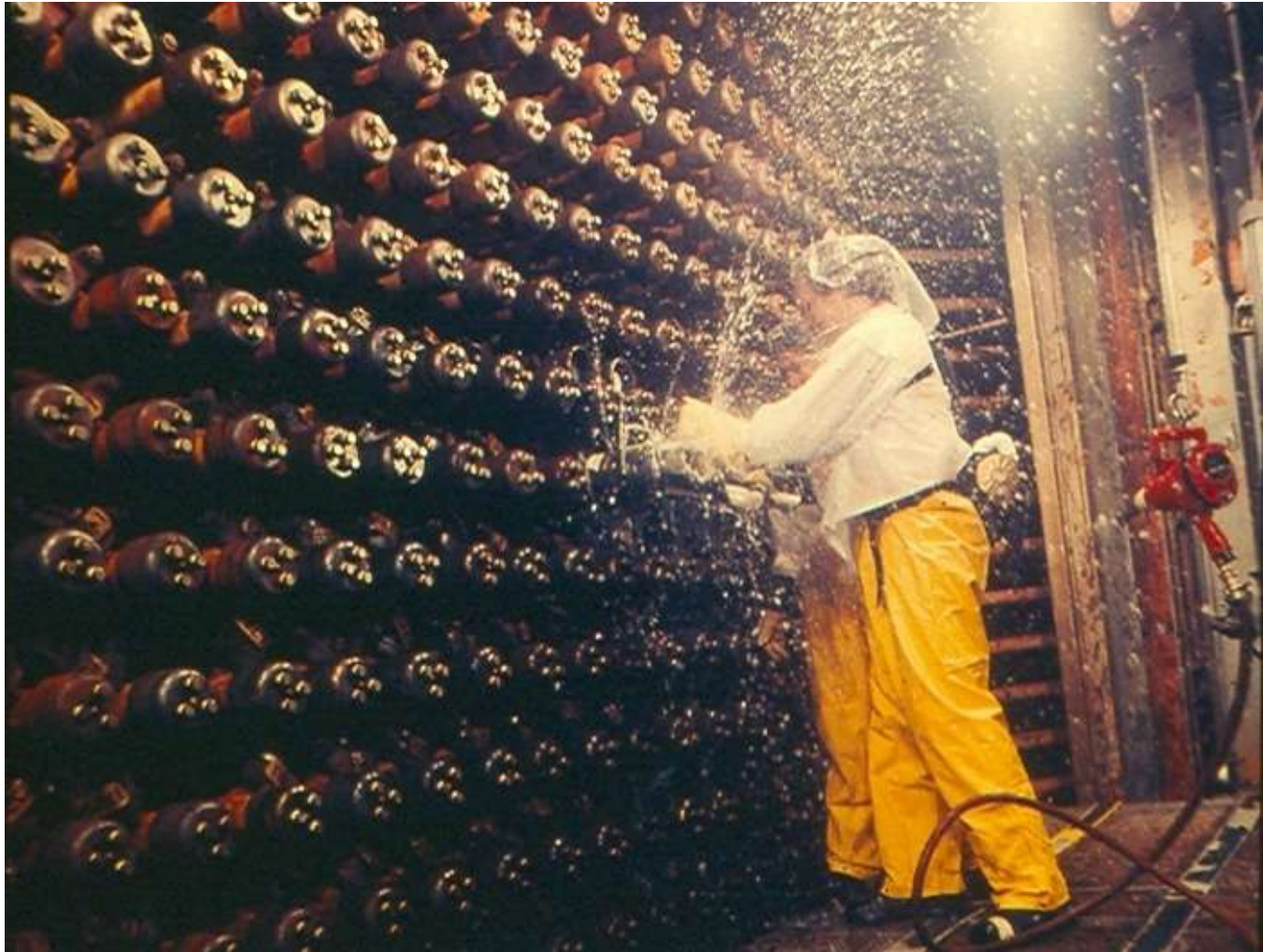
100-N 1962



N Reactor Fuel



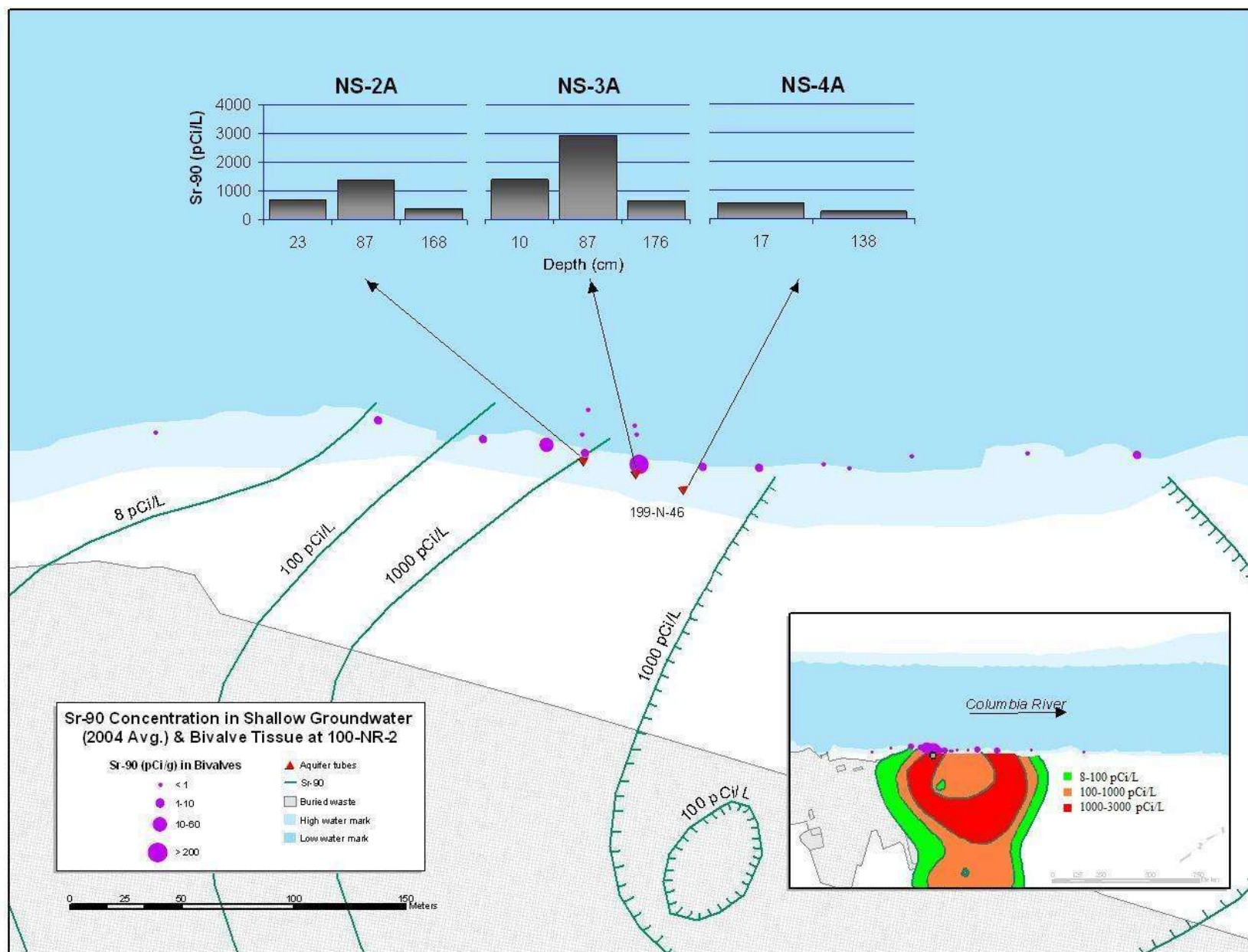
| | |
|-----------------------|---------------------------------------|
| Length | 26 inches |
| Outer | 2.7-inch outer diameter |
| | 1.7-inch inner diameter |
| Inner | 1.3-inch outer diameter |
| | .5-inch inner diameter |
| Combined weight | 52 pounds |
| Fuel | Metallic Uranium |
| Cladding | Zircaloy-2 |
| Enrichment | 0.71 to 1.25 percent U ²³⁵ |

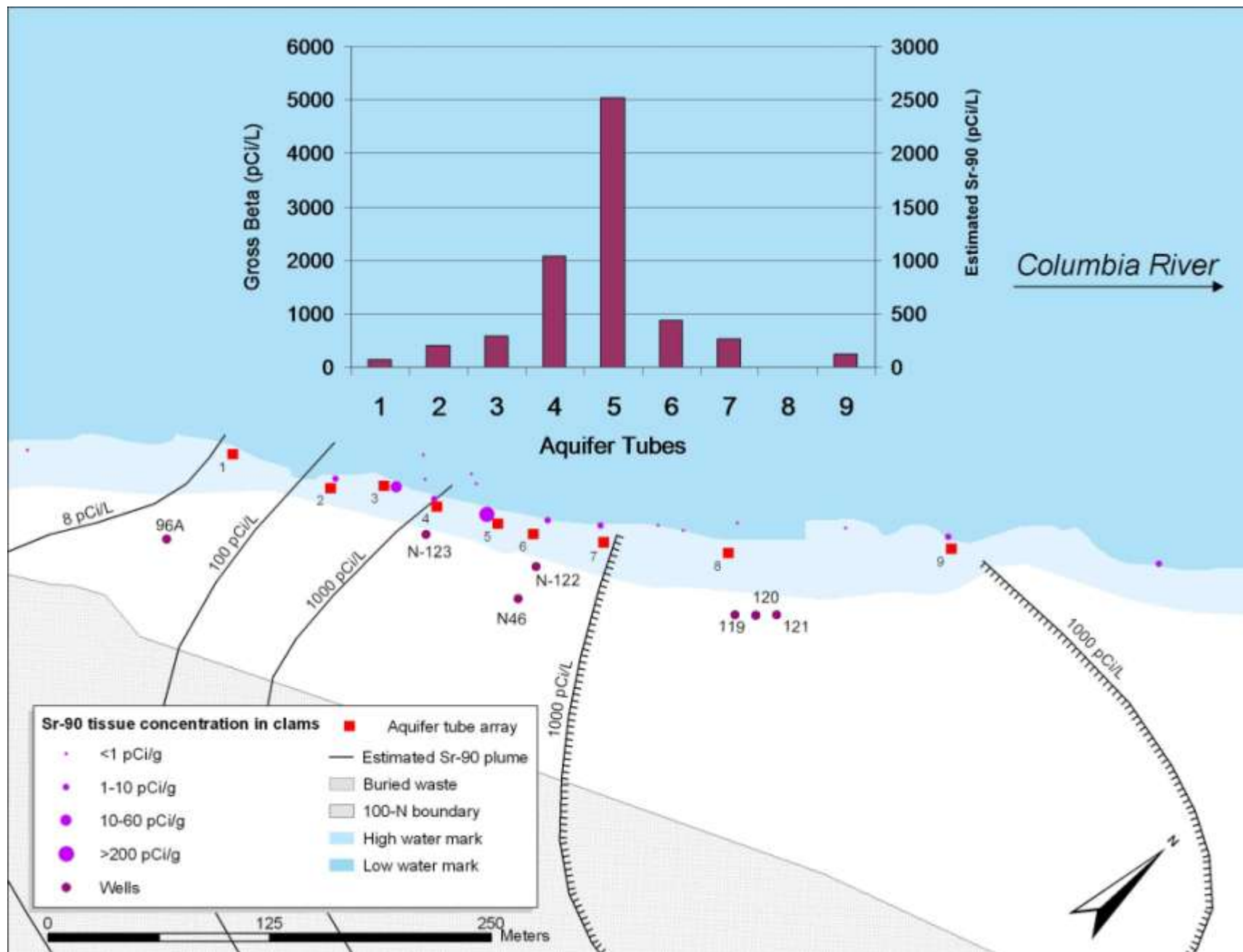




Effects of Natural Radioactive Decay

- Sr-90 Half-Life is 28.6 years.
- 50% reduction of Sr-90 in soils and groundwater in less than 30 years
- 90% reduction of Sr-90 in soils and groundwater in less than 95 years

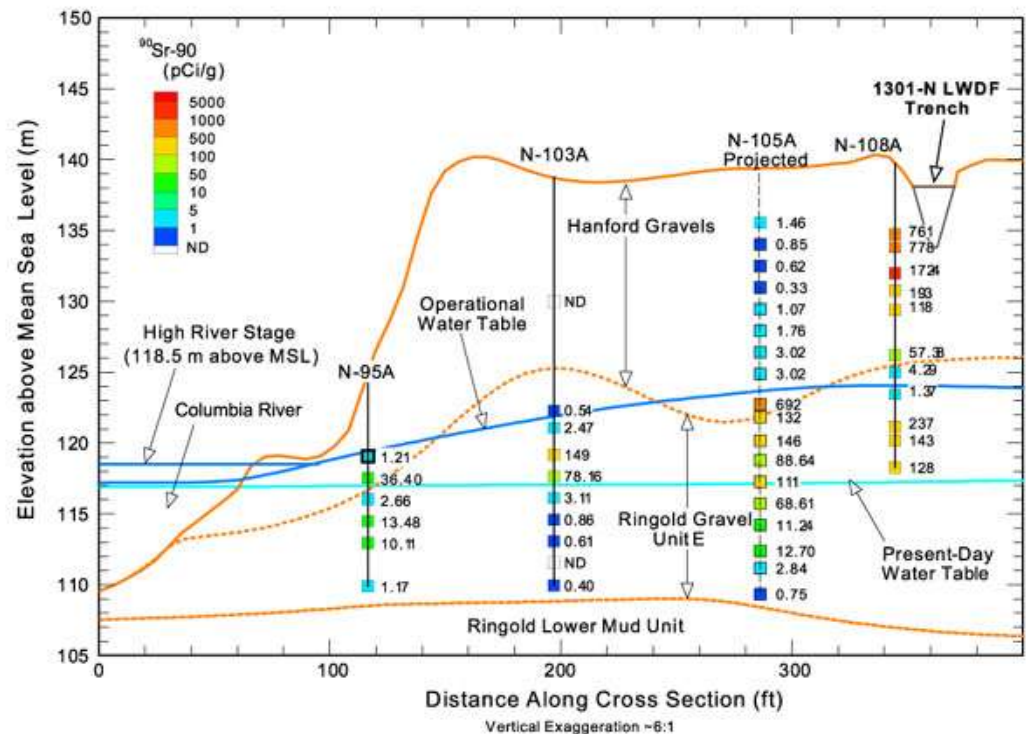




Excavation and removal of all the contaminated soils from the trenches to the river will not result in cleaning up the aquifer

- A concentration of >0.12 pCi/g Sr-90 in the wetted soils of the aquifer will exceed the drinking water standard of 8 pCi/L
- This level is exceeded between the trenches and the Columbia River

Sr-90 Concentration Levels on Soils in Nearby Wells



Geochemistry of Strontium-90

The mobility of Sr-90 is determined by the ability of the different rock types to adsorb the Sr-90 available in the water. This is expressed by a simple ratio known as the bulk distribution coefficient also known as the K_d , which is the ratio of the mass on the solid phase per unit mass of solid phase divided by concentration in the water phase:

$$K_d = \frac{\text{mass of solute on solid phase per unit mass of solid phase}}{\text{concentration of solute in solution}}$$

The K_d for Strontium-90 has been measured in over 80 separate tests for the 100-N soils (Serne and Legore, 1996). For the coarse grained sediments of the Ringold Formation, found in this area, Serne recommends a bulk distribution coefficient of 15 ml/g

What is a picoCurie ?

- 1 Curie (Ci) = That quantity of radioactive material that results in 37 billion disintegrations/second, equivalent to 1 gram radium
- 1 picoCurie = Pico" is a metric prefix that means one one-millionth of one one-millionth = 1/trillionth (10^{-12}) of 1 curie
- 1 picoCurie = That quantity of radioactive material that results in 2.2 nuclear disintegrations/minute

Pump and Treat System Operations

